Intelligence 63 (2017) 45–50

Contents lists available at ScienceDirect

Intelligence

journal homepage: www.elsevier.com/locate/intell

Childhood IQ and survival to 79: Follow-up of 94% of the Scottish Mental Survey 1947

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ARTICLE INFO

Keywords:
Childhood intelligence
IQ
All-cause mortality
SMS1947
Sex differences

ABSTRACT

Objective: To extend previous literature that suggests higher IQ in youth is associated with living longer. Previous studies have been unable to assess reliably whether the effect differs across sexes and ages of death, and whether the effect is graded across different levels of IQ.

Methods: We test IQ-survival associations in 94% of the near-entire population born in Scotland in 1936 who took an IQ test at age 11 (n = 70,805) and were traced in a 68-year follow-up.

Results: Higher IQ at age 11 years was associated with a lower risk of death (HR = 0.80, 95% CI = 0.79, 0.81). The decline in risk across categories of IQ scores was graded across the full range with the effect slightly stronger in women (HR = 0.79, 95% CI = 0.77, 0.80) than in men (HR = 0.82, 95% CI = 0.81, 0.84). Higher IQ had a significantly stronger association with death before and including age 65 (HR = 0.76, 95% CI = 0.74, 0.77) than in those participants who died at an older age (HR = 0.79, 95% CI = 0.78, 0.80).

Conclusions: Higher childhood IQ is associated with lower risk of all-cause mortality in both men and women. This is the only near-entire population study to date that examines the association between childhood IQ and mortality across most of the human life course.

1. Introduction

It is now well-documented that higher childhood intelligence, as ascertained from standard tests, is associated with living longer. This is the case for both all-cause mortality (Batty et al., 2008b; Batty et al., 2009b; Hart et al., 2005; Whalley & Deary, 2001), and mortality from specific causes, particularly cardiovascular disease, (Batty et al., 2008a; Deary, Weiss, & Batty, 2010; Hemmingsson, Melin, Allebeck, & Lundberg, 2009), accidents (Batty, Gale, Tynelius, Deary, & Rasmussen, 2009) and suicide (Batty et al., 2010; Gunnell, Magnusson, & Rasmussen, 2005). The most recent meta-analysis reported that a one standard deviation advantage in early life cognitive ability test scores is related to a 24% reduction in the risk of death during a follow-up of up to 69 years (Calvin et al., 2011). However, a number of questions regarding the associations between IQ and mortality remain under-explored. Most notably, with many samples either comprising only men (Batty et al., 2008a; Batty et al., 2009b; Hemmingsson et al., 2009), or being insufficiently powered to compute sex-specific effect estimates (Calvin et al., 2011), little is known about the link between pre-adult IQ and mortality in women. In one of the few exceptions, Whalley and Deary (Whalley & Deary, 2001) reported a stronger protective association of higher IQ and lower mortality in women, but could not rule out that this difference was cohort-specific due to a larger number of higher intelligence men dying in active service in the second world war. One report from a post-war cohort study did not detect an association between IQ and mortality in women (Kuh, Richards, Hardy, Butterworth, & Wadsworth, 2004), and the other one detected the association between IQ and mortality only at the age of 60 and above (Lager, Bremberg, & Vågerö, 2009).

Another important issue concerns the nature of the association between IQ and mortality. Whereas some studies showed that the association is graded across the whole range of IQ (Batty et al., 2009b; Hemmingsson et al., 2009; Whalley & Deary, 2001), others reported that it is driven by the accumulation of risk factors at the lower end of the IQ distribution (Kuh et al., 2004). Furthermore, higher childhood IQ may be protective against early deaths, but may not be associated with deaths in older age, as was found in one study (Hart et al., 2005). However, these studies were underpowered to reliably assess the associations across the whole range of cognitive ability, ages of death, and to examine potential sex differences in the IQ-mortality association.

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http://dx.doi.org/10.1016/j.intell.2017.05.002
Received 5 August 2016; Received in revised form 15 May 2017; Accepted 15 May 2017
Available online 19 May 2017

In the present study we were able to address all of the above limitations. The data for our study are a near-entire year of birth cohort from Scotland, with a long period of follow-up and a large number of deaths. We assessed the association between childhood IQ and survival to age 79, whether the relationship is graded, and also if there was any differential effect with respect to sex.

2. Method

2.1. Sample

On June 4, 1947 almost all individuals born in 1936 and attending Scottish schools sat an intelligence test as part of the Scottish Mental Survey 1947 (SMS1947). Testing was conducted by the Scottish Council for Research in Education with an aim to assess the intelligence levels of the entire generation of children born in 1936 and attending schools in Scotland in June 1947, as part of a project to follow cross-generational changes in mean intelligence levels (Deary, Whalley, & Starr, 2009a; Maxwell, 1969). Intelligence test scores, from a paper-and-pencil test administered by teachers, were obtained for 70,805 children (50.6% boys). This was about 94% of the estimated 1936-born population of Scotland (n = 75,286). The remaining 6% or so did not attend school on the day of testing.

To ascertain mortality information for the whole year of birth, tracing was done using the National Health Service Central Register (NHSCR) in Dumfries for participants traceable in Scotland and Northern Ireland, and Health and Social Care Information Centre (HSCIC) in Southport for those traceable in England and Wales. Tracing was conducted using participants' date of birth, surname, forename, sex, and name and location of school.

Vital status and death registration data were linked to participants with complete SMS1947 intelligence test scores. Intelligence test results and vital status data were available for 66,616 participants (51% men). That is, 94% of those who took part in the Scottish Mental Survey 1947 were traced and had childhood intelligence test data. A flow chart representing sample composition is presented in Fig. 1. Ethical approval for the study was obtained from Scotland A Research Ethics Committee (12-SS-0024). Support for linkage without consent was given under section 251 of the NHS Act 2006 by The Confidentiality Advisory Group of the Health Research Authority for participants traced in England and Wales (Ref. ECC 6-02(FT4 2012)), and by the Privacy Advisory Committee for participants traced in Scotland (Ref. 39–12) (Brett & Deary, 2014).

SMS1947 = Scottish Mental Survey 1947. Censored = unknown vital status at follow-up date. Reasons are given in squares below: Embarked = Emigrated abroad. Armed Forces = Joined Armed Forces. Lost to follow-up = No information available.

2.2. Measures

2.2.1. Childhood intelligence

To assess childhood intelligence at age 11, the Moray House Test (MHT) no. 12. was used (Deary, Gow, Pattie, & Starr, 2012; Deary, Whalley, & Starr, 2009b; Deary, Whiteman, Starr, Whalley, & Fox, 2004). The test contains 71 items, including reasoning, word classification, analogies, and spatial orientation, and had a maximum possible score on the test of 76. The test was group-administered by teachers in classrooms and had a time constraint of 45 min. The MHT was concurrently validated in 1947 against the Terman-Merrill revision of the Binet scales (Deary et al., 2007). It has been well externally-validated since, and is a reliable measure of general intelligence (Deary et al., 2004; Deary et al., 2012) that shows high rank-order stability across the life-span (Deary, Whalley, Lemmon, Crawford, & Starr, 2000).

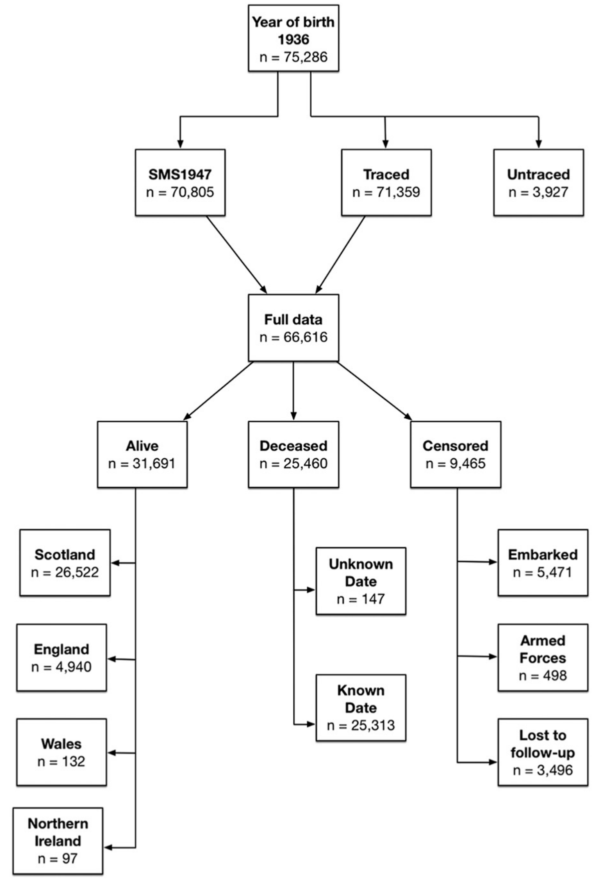

Fig. 1. Sample composition and vital status at follow-up.

2.2.2. Date of death

Vital status and date of death, where appropriate, were supplied by NHSCR Dumfries for participants traced in Scotland and Northern Ireland, and by HSCIC Southport for those located in England and Wales.

2.3. Analyses

The time-to-event variable (in days) was calculated using the participant's date of birth as a starting point. The censoring date is the date of the event that marks the end of the time-to-event variable, and it differs across participants as follows: for those known to be alive in England, Scotland, Wales and Northern Ireland censoring date was 26th June 2015 (end of follow-up). For those embarked (i.e. emigrated abroad), joined the Armed Forces and never re-registered with a general practitioner (GP), or otherwise lost to follow-up (i.e., cancelled their registration with a GP), the last known date of registration with a GP was used. For the deceased participants with known date of death, date of death is used as the end point of the time-to-event variable. For the deceased participants with an unknown date of death, the date of the last known GP registration was used as a censoring date. The exact number of participants for each of the categories is given in Fig. 1. Cox proportional hazard models were used to assess mortality risk associated with childhood IQ scores, controlling for age at the time of IQ testing. Hazard Ratios (HRs) were shown to illustrate change in risk both per 1-SD increase in IQ scores, and per IQ decile increase, and therefore are a relative measure of mortality risk. In all analyses, the lowest IQ category serves as a reference for the change in mortality risk. All analyses were computed in R environment, version 3.1.3 (R Core Team, 2015), using the ‘survival’ package (Therneau, 2015).